

CLAIMS

1. A variable frequency tag comprising:
 - (a) interfacing means for receiving interrogating radiation at the tag and generating a corresponding received signal, and for receiving a signature signal and radiating corresponding response radiation;
 - (b) processing means for receiving the received signal and outputting the signature signal in response, the signature signal including a signature code for use in identifying the tag;
 - (c) clocking means for controlling a rate at which the signature code is output; and
 - (d) power supplying means for providing an electrical potential difference for energizing the tag,characterised in that the clocking means is operable to output the signature code at a rate which is governed by the magnitude of the received signal.
2. A tag according to Claim 1 wherein the clocking means includes first and second oscillators, the first oscillator for clocking the processing means, and the second oscillator for controlling the frequency at which the signature code is output from the tag in response to the magnitude of the received signal.
3. A tag according to Claim 2 wherein the first oscillator is arranged to oscillate at a substantially constant frequency.

4. A tag according to Claim 1, 2 or 3 wherein the supplying means is coupled to the interfacing means, the supplying means being operable to derive the potential difference from the received signal.
5. A tag according to Claim 4 wherein the supplying means includes a transformer for enhancing the potential difference applied to the clocking means and the processing means.
6. A tag according to Claim 5 wherein the transformer is a piezo-electric transformer.
7. A tag according to Claim 6 wherein the transformer includes a multilayer primary region arranged to be driven by the received signal, and a single-layer secondary region at which the potential difference is generated, the primary and secondary regions being mechanically coupled.
8. A tag according to any preceding claim wherein the supplying means includes potential difference limiting means for preventing excess supply potential damage to the processing means and the clocking means.
9. A tag according to any preceding claim wherein the interfacing means comprises an antenna assembly operable to generate the response radiation from the received radiation by modulating reflectivity of the antenna assembly depending upon tag power consumption.

10. A tag according to any one of Claims 1 to 8 wherein the interfacing means comprises an antenna assembly operable to generate the response radiation from the received radiation by modulating reflectivity of the antenna assembly, the processing means being connected in direct communication with the antenna assembly for modulating reflectivity of said assembly with the signature code.
11. A tag according to Claim 1, wherein the clocking means is operable to clock the processing means at a rate which increases as the potential difference increases.
12. A tag according to Claim 11 wherein the clocking means is operable to increase the rate at which the processing means is clocked in a stepwise manner in response to increase in the potential difference.
13. A tag according to Claim 12 wherein the clocking means comprises digital dividing means for dividing a master clock signal to generate a clocking signal for clocking the processing means, the master clock signal being derived from the received signal.
14. A tag according to Claim 12 wherein the clocking means comprises digital dividing means for dividing a master clock signal generated by oscillating means, the master clock signal being substantially constant in operation.

15. A tag according to Claim 11 wherein the clocking means is operable to increase the rate at which the processing means is clocked in a substantially linear manner in response to increase in the potential difference.
16. A tag according to Claim 11 wherein the clocking means is operable to increase the rate at which the processing means is clocking in a substantially logarithmic manner in response to increase in the potential difference.
17. A tag according to Claim 11 wherein the clocking means includes an oscillator comprising a plurality of serially connected logic gates with feedback therearound for generating a clocking signal for clocking the processing means, the logic gates having a signal propagation therethrough which is a function of the potential difference.
18. A tag according to Claim 17 wherein the oscillator comprises a ring-of-three logic gates configured with feedback therearound for generating the clocking signal.
19. A tag according to any preceding claim, wherein the processing means is operable to dissipate a majority of power required to operate the tag.
20. A tag according to any preceding claim, wherein the processing means is operable to output the signature code repetitively with pause intervals therebetween during which the code is not output.

21. A tag according to claim 20 wherein the pause interval corresponds to at least 90% of an interval at which the signature code is output.
22. A tag according to any preceding claim, wherein the processing means is receptive to one or more synchronisation pulses in the received signal and is switchable to a temporary wait state in which the processing means does not output its signature code when the one or more synchronisation pulses do not align to a synchronisation time window after the tag outputs its signature code.
23. A tag according to any preceding claim, wherein the processing means includes CMOS logic circuits for generating the signature code, the logic circuits operable to consume increasing power in operation as their clocking rate is increased.
24. An interrogating device for interrogating one or more tags according to any preceding claim, the device characterised in that it incorporates:
 - (a) signal generating means for generating an interrogating signal;
 - (b) interrogation interfacing means for radiating the interrogating signal as interrogating radiation towards said one or more tags, and for receiving response radiation from said one or more tags and generating a corresponding response signal; and
 - (c) signal processing means for filtering the response signal and thereby isolating signal spectral components from each of said one or more tags and extracting signature codes from the signal components for identifying said one or more tags.

25. A device according to Claim 24 wherein the interrogation interfacing means comprises a directional antenna assembly for interrogating said one or more tags from a plurality of relative angles, and the signal processing means is operable to process response signals arising at the device for the plurality of relative angles to determine bearing of said one or more tags with respect to the device.
26. An interrogating device for interrogating one or more tags according to any one of Claims 5, 6 or 7, the device characterised in that it incorporates:
- (a) signal generating means for generating an interrogating signal comprising an excitation component for exciting one or more transformers of the tags into resonance;
 - (b) interrogation interfacing means for radiating the interrogating signal as interrogating radiation towards said one or more tags, for exciting the one or more transformers into resonance for generating an enhanced potential signal within said one or more tags, and for receiving response radiation from said one or more tags and generating a corresponding response signal; and
 - (c) signal processing means for filtering the response signal and thereby isolating signal spectral components from each of said one or more tags and extracting signature codes from the signal components for identifying said one or more tags.
27. A device according to Claim 26 including means for frequency sweeping the excitation component in frequency for one or more of:
- (a) operating the tags at resonance of their one or more transformers; and
 - (b) resolving contention between simultaneously responding tags.

28. A device according to Claim 24, 25, 26 or 27 including tag transporting means for transporting in operation said one or more tags spatially in relation to the interrogation interfacing means, the signal processing means being operable to sample the response signal repetitively at intervals for resolving multiple tag contention.
29. A device according to any one of claims 24 to 29 wherein the interrogation interfacing means comprises a plurality of antennae spatially disposed in relation to said one or more tags for radiating the interrogating radiation, the signal processing means operable to switch in sequence through the antennae to interrogate said one or more tags from varying distances, and to process corresponding response signals at the device for resolving multiple tag contention.
30. A tagging system incorporating one or more tags according to any one of Claims 1 to 23 and a device according to any one of Claims 24 to 29 for interrogating and identifying said one or more tags.
31. A method of interrogating a variable frequency tag using an interrogating device, the method characterised in that it includes the steps of:
- (a) emitting interrogating radiation from the device towards the tag;
 - (b) receiving the interrogating radiation at the tag and generating a corresponding received signal;
 - (c) receiving the received signal at processing means of the tag;

- (d) outputting a signature signal from the processing means in response to receiving the received signal thereat, the signature signal including a signature code for use in identifying the tag, the signature code being output at a rate dependent upon a supply potential difference energizing the tag;
 - (e) radiating the signature signal as response radiation from the tag;
 - (f) receiving the response radiation from the tag at the device and generating a corresponding interrogation received signal thereat;
 - (g) filtering the interrogation received signal in the device to isolate one or more spectral components corresponding to the tag, extracting the signature code of the tag from said one or more spectral components and then correlating said signature code with one or more signature templates to identify the tag.
32. A method according to Claim 31 wherein the supply potential difference is derived from the received signal.
33. A method according to Claim 32 where the supply potential difference is enhanced by using a piezo-electric step-up transformer.
34. A method according to Claim 33 wherein the interrogating radiation includes a component for exciting the transformer into vibration, the method involving sweeping the component in frequency for determining when the tag is operating at resonance of its transformer.

35. A method of resolving contention between a plurality of variable frequency tags interrogated from an interrogating device, the method characterised in that it includes the steps of:
- (a) emitting interrogating radiation from the device towards the tags;
 - (b) receiving the interrogating radiation at each tag and generating a corresponding received signal thereat;
 - (c) receiving at each tag the received signal at processing means of the tag;
 - (d) outputting a signature signal from the processing means of each tag in response to receiving the received signal thereat, the signature signal including an associated signature code for use in identifying the tag, the signature code being output at a rate dependent upon a supply potential difference energizing the tag, the potential difference being derived from the received signal of the tag;
 - (e) radiating the signature signal of each tag as response radiation from the tag;
 - (f) receiving the response radiation from the tags at the device and generating a corresponding interrogation received signal thereat;
 - (g) filtering the interrogation received signal at the device to isolate one or more spectral components corresponding to the tags, extracting the signature codes of the tags from said one or more spectral components and then correlating said signature codes with one or more signature templates for identifying the tags; and
 - (h) if contention exists with respect to one or more of the components, repetitively modifying a spatial relationship between the device and the tags and repeating steps (a) to (g) until the contention is resolved.

36. A method of resolving contention between a plurality of variable frequency tags interrogated from an interrogating device, the method characterised in that it includes the steps of:
- (a) emitting interrogating radiation from the device towards the tags;
 - (b) receiving at each tag the interrogating radiation and generating a corresponding received signal thereat;
 - (c) receiving at each tag the received signal at processing means of the tag;
 - (d) outputting a signature signal from the processing means of each tag in response to receiving the received signals thereat, the signature signal including an associated signature code for use in identifying the tag, the signature code being output at a rate dependent upon a supply potential difference energizing the tag, the potential difference being derived from the received signal of the tag, the signature code being output repetitively with pauses therebetween during which the code is not output;
 - (e) radiating the signature signal of each tag as response radiation from the tag;
 - (f) receiving the response radiation from the tags at the device and generating a corresponding interrogation received signal thereat;
 - (g) filtering the interrogation received signal at the device to isolate one or more spectral components corresponding to the tags, extracting the signature codes of the tags from said one or more spectral components and then correlating said signature codes with one or more signature templates for identifying the tags; and
 - (h) if contention exists with respect to one or more of the components, repeating steps (a) to (g) until the contention is resolved.

37. A method of resolving contention between a plurality of variable frequency tags interrogated from an interrogating device, the method characterised in that it includes the steps of:
- (a) emitting interrogating radiation from the device towards the tags;
 - (b) receiving the interrogating radiation at each tag and generating a corresponding received signal thereat;
 - (c) receiving at each tag the received signal at processing means of the tag;
 - (d) identifying one or more pulses present in the received signal at each tag, outputting an associated signature signal from the processing means of the tag in response to receiving the received signal thereat depending on whether or not said one or more pulses are coincident with a time window associated with the tag, the signature signal including an associated signature code for use in identifying the tag, each signature code output at a rate dependent upon a supply potential difference energizing the tag, the potential difference being derived from the received signal of the tag;
 - (e) radiating the signature signals as response radiation from one or more of the tags;
 - (f) receiving the response radiation from said one or more of the tags at the device and generating a corresponding interrogation received signal thereat;
 - (g) filtering the interrogation received signal at the device to isolate one or more spectral components corresponding to said one or more of the tags, extracting the signature codes of said one or more of the tags from said one or more spectral components and then correlating said signature codes with one or more signature templates for identifying said one or more of the tags; and

- (h) if contention exists with respect to one or more of the components, outputting said one or more pulses in the interrogating radiation to temporarily disable one or more of the tags from responding and repeating steps (a) to (g) until the contention is resolved.

38. A method according to Claim 37 wherein the time window of each tag is temporally dependent upon a clocking rate at which the processing means of the tag is clocked, the clocking rate in turn being dependent upon the supply potential difference of the tag.